DVK-BT900-Sx Development Kit

Hardware Integration Guide

Version 1.0

DVK-BT900-SA, DVK-BT900-SC

global solutions: local support™

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REVISION HISTORY

Revision	Date	Changes
1.0	07 Nov 2014	Initial version

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1 LAIRD DVK-BT900-SX DEVELOPMENT KIT

Part number: DVK-BT900-SA / DVK-BT900-SC
Applicable to the following module part numbers:

- BT900-SA Intelligent BTv4.0 Dual Mode Module featuring *smart*BASIC (internal antenna)
- BT900-SC Intelligent BTv4.0 Dual Mode Module featuring *smart*BASIC (u.FL connector)

2 OVERVIEW

The Laird DVK-BT900 development kit provides a platform for rapid wireless connectivity prototyping, providing multiple options for the development of Classic Bluetooth and Bluetooth Low Energy (BLE) applications.

This manual is for Rev. 01 and later of the development PCB and relates to DVK-BT900-V01 and later on the silkscreen of the PCB motherboard itself. The complete functionality of the development kit hardware requires the use of Laird BT900 series *smart*BASIC runtime engine FW version v9.1.2.0 or greater.

2.1 Introduction

The development kit is designed to support the rapid development of applications and software for the BT900 series of BT / BLE modules featuring Laird's innovative event driven programming language – *smart*BASIC. More information regarding this product series (including a detailed module User's Manual and *smart*BASIC user guide) is available on the Laird's BT900 product pages.

2.2 Package Contents

All kits contain the following items:

Development Board	The development board has the required BT900 module already soldered onto it and exposes all the various hardware interfaces available.
Power Option	USB cable – Type A to mini type B. The cable also provides serial communications via the FTDI USB – RS232 converter chip on the development board.
Pin Headers x 4	Supplied to allow simple connection to SIO lines via the through hole plated areas JP2, JP3, JP4 and JP5. The headers are 2 x 5 way and are 2.54 mm pitch.
Jumper Pin Cables x 6	Supplied to allow simple connection to the various pin headers for prototyping purposes.
Web link Card	Provides links to additional information including the BT900 user manual, firmware, Laird BT900 mobile apps, terminal utilities, schematics, quick start guides, and firmware release notes.

3 DVK-BT900– MAIN DEVELOPMENT BOARD

This section describes the BT900 development board hardware. The BT900 development board is delivered with the BT900 series module loaded with integrated *smart* BASIC runtime engine FW but no onboard *smart* BASIC application; because of this, it starts up in AT command mode by default.

smart BASIC applications are simple and easy to develop for any BT / BLE application. Sample *smart* BASIC applications are available to download from the Laird's BT900 product pages or via the Technical Support Site https://laird-ews-support.desk.com/

The BT900 development board is a universal development tool to highlight the capabilities of the BT900 module. The development kit is supplied in a default configuration which should be suitable for multiple experimentation options. It also offers a number micro-DIP switches that help isolate on-board sensors and UART from the BT900 module to create different configurations. This allows you to test different operating scenarios.

The development board allows the BT900 series module to physically connect to a PC via the supplied USB cable for development purposes. The development board provides USB-to-Virtual COM port conversion through a FTDI chip – part number FT232R. Any Windows PC (XP or later) should auto-install the necessary drivers; if your PC cannot locate the drivers, you can download them from http://www.ftdichip.com/Drivers/VCP.htm

3.1 Key Features

The BT900 development board has the following features:

- BT900 series module soldered on-board.
- Power supply options for powering development board from:
  - USB
  - external DC supply
  - AAA batteries (3xAAA battery holder fitted on underside of development board)
- Regulated 3.3 V for powering the BT900 module. Optional regulated 1.8 V for powering the BT900 module.

  NOTE: 1.8V operation not supported in BT900 module *smart*BASIC runtime engine FW v9.1.2.0.

- USB to UART bridge (FTDI chip).
- BT900 UART can be interfaced to:
  - USB (PC) using the USB-UART bridge
  - External UART source (using IO break-out connector when development board powered from DC jack)
- Current measuring (for BT900 module only) options:
  - Pin header (Ammeter)
  - Current shunt monitor IC (volt meter or oscilloscope)
  - Series resistor for differential measurement (oscilloscope)
- IO break-out (four 2x5-pin 2.54mm pitch headers) connectors interface for plugging-in external modules/sensors, and accessing all interfaces of the BT900 module [UART, SPI, I2C, SIO (DIO or AIN (ADCs)), PWM, FREQ].
- Two Buttons and two LEDs for user interaction.
- Two on-board sensors (analogue output): Temperature and Trim Pot.
- One buzzer.
- One on-board SPI sensor/device (serial Eeprom).
- One on-board I2C sensor /device (RTC chip).
- Micro DIP switches that allow the on-board sensors, LED's (and USB UART FTDI bridge) to be disconnected from BT900 module.

- External 32.768 kHz crystal oscillator (for Laird use or future use). Not required for use with BT900 and therefore is disabled by jumper fitted on CON6.
- *smart*BASIC runtime engine FW upgrade capability:
  - Via UART (using the FTDI USB-UART).
- *smart*BASIC application script loading capability:
  - Via UART (using the FTDI USB-UART).
  - Via OTA (Over the Air)

3.2 Understanding the Development Board

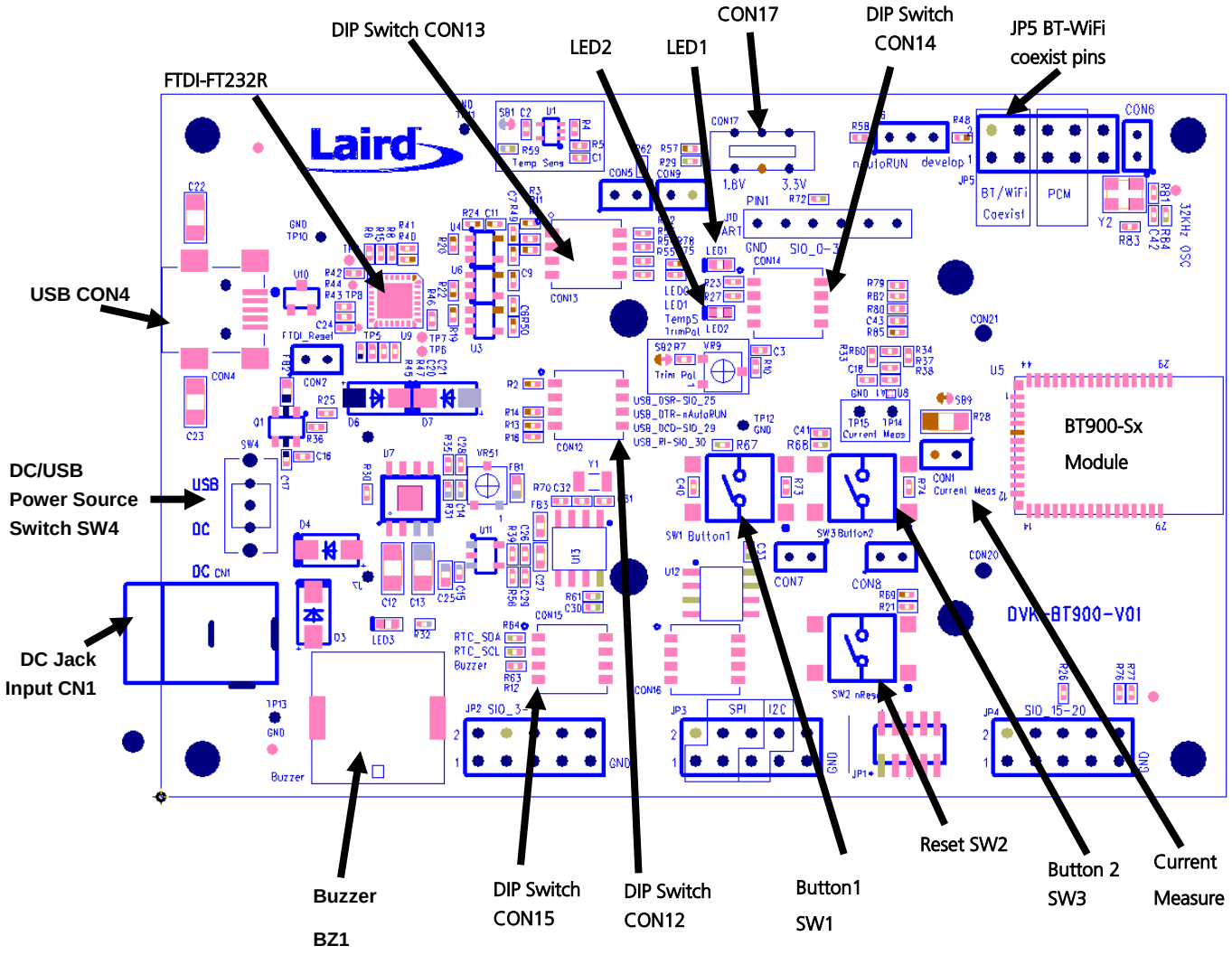


Figure 1: BT900 development board

Important! To ensure correct 'out of the box' configuration, the BT900 development board must be set according to Figure 2.

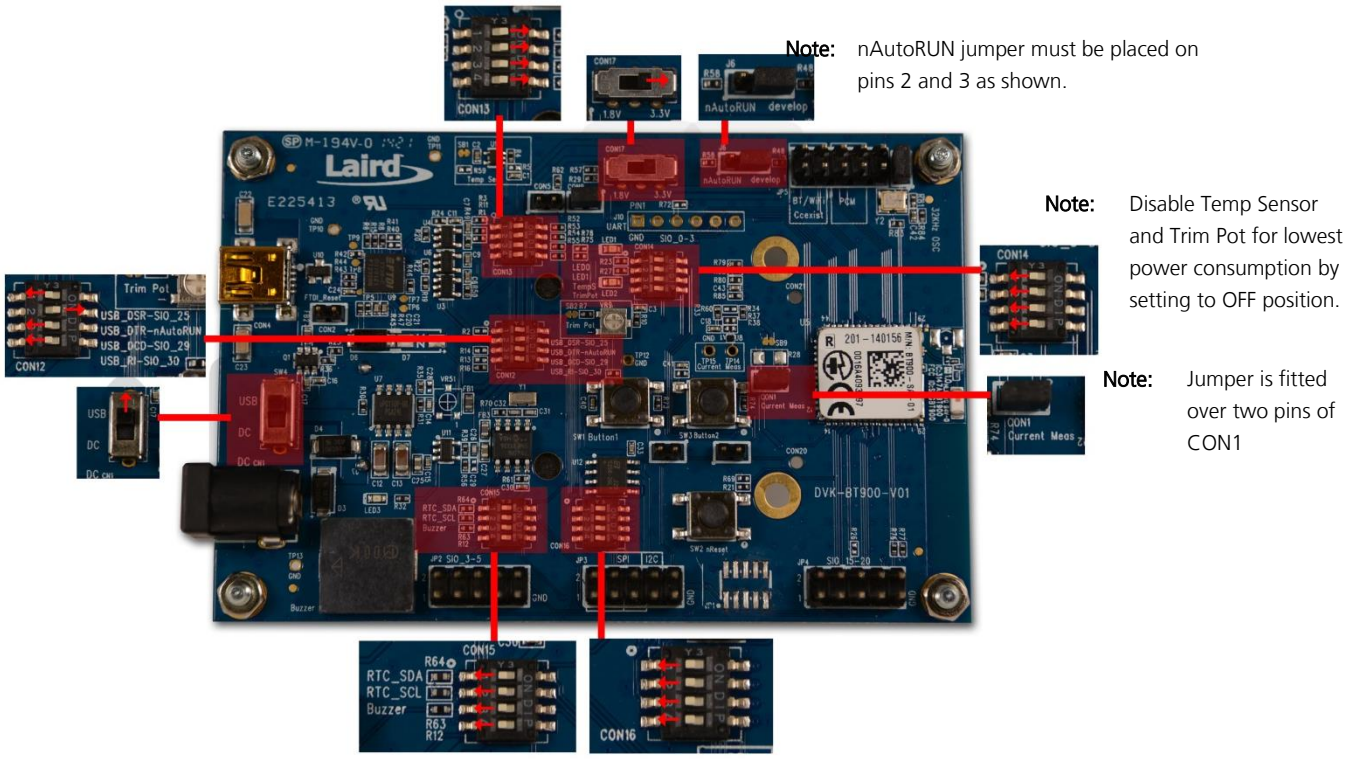


Figure 2: Correct development board settings

4 FUNCTIONAL BLOCKS

The development board is formed from the following major functional blocks:

4.1 Power Supply

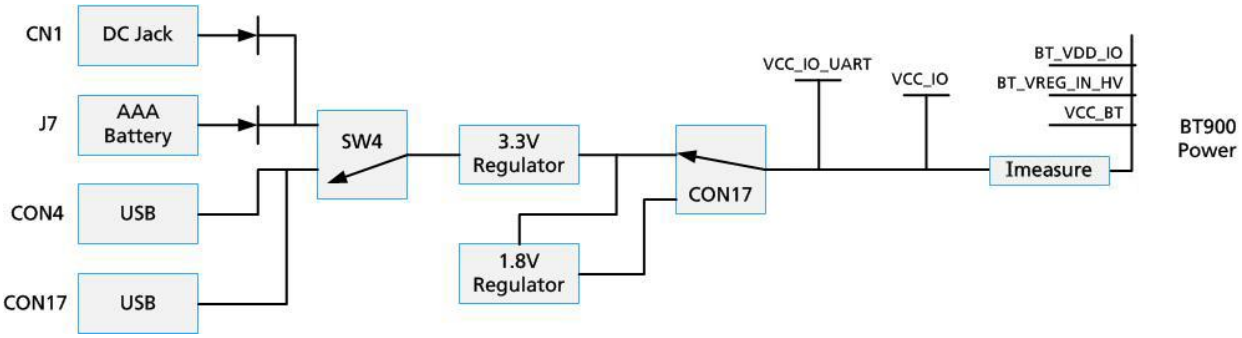


Figure 3: BT900 devboard power supply

The development board can be powered from 4.5-5.5 V supply (into DC jack connector CN1), 3 AAA batteries (holder J7 mounted on underside of board), or from the USB (type mini-B connector or CON4). The power source fed into DC jack (CN1) or 3 AAA batteries (J7) is combined together through diodes (diode-OR) and fed to the SW4 switch that allows selection of power source between either USB or the DC jack/AAA.

The 5V from the USB or the DC jack/AAA batteries is regulated down to 3.3V with an on-board regulator on the development board.

The CON17 default is to select regulated 3.3V.

Note: The development board has a 1.8V regulator for the possibility of powering the BT900 module from a 1.8V rail (by changing the CON17 position). **BT900 1.8V operation is not supported in the current firmware (v9.1.2.0).**

The development board's 3.3V regulator provides power to the BLE module and USB UART bridge interface as well as to sensors on the development board.

	Switch Positions	
Development Board Power Source	**SW4**	**CON17 select BT900 Power source**
USB (CON4)	Position USB	Position 3.3V always (for 3.3V operation)
DC jack (CN1) or AAA battery (J7).[Note 1]	Position DC	Position 3.3V always (for 3.3V operation)

Note 1: The development board is powered from DC jack (or AAA batteries) when an external UART source is to be interfaced to BT900 module (using breakout connector JP5).

On the development board, the power domain:

- VCC_BT supplies the BT900 series module only. Current measuring block on development board only measures the current into power domain VCC_BT and VREG_IN_HV, VDD_PADS (when the BT900 is powered by 3.3V (CON17 in the 3.3V position).
- VREG_IN_HV, VDD_PADS supplies the BT900 module (BT radio chip section) only.
- VCC_IO_UART supplies the FTDI chip IO and all other sensors and circuitry.

- VCC_IO is wired to the header connectors (JP2, JP3, JP4, JP5) via R29 and can be used to power external devices sensors.

4.2 Reset Button

The development board has a reset button (SW2). The reset is active low (SW2 pushed down). To view its location, refer to Error! Reference source not found..

4.3 4-Wire UART Serial Interface

The development board provides access to the BT900 module 4-wire UART interface (TX, RX, CTS, RTS) either through USB (via U9 FTDI USB-UART convertor chip) or through a breakout header connector J10. Refer to Figure 4.

Note: BT900 module provides 4-wire UART interface on the HW and the other four signals (DTR, DSR, DCD, RI) which are low bandwidth signals can be implemented in a *smart*BASIC application, using any spare digital SIO pins.

4.3.1 UART Mapping

UART connection on the BT900 series module and FTDI IC are shown in table below. Refer to Figure 4 to see how the BT900 series module UART is mapped to the breakout header connector (J10).

Table 1: UART mapping

BT900 SIO	BT900 Default function	FTDI IC UART
SIO.1	UART_TX (output)	USB_RX
SIO.0	UART_RX (input)	USB_TX
SIO.2	UART_RTS (output)	USB_CTS
SIO.3	UART_CTS (input)	USB_RTS

Additional SIO pins are also routed to the FTDI chip via a switch block. For example, the nAutoRUN input pin on the module can be driven by the DTR output pin of the FTDI chip. This allows testing the $autorun$ application on boot.

4.3.2 UART Interface Driven by USB

- **USB Connector.** The development kit provides a USB Type mini-B connector (CON4) which allows connection to any USB host device. The connector optionally supplies power to the development kit and the USB signals are connected to a USB to serial convertor device (FT232R), when SW4 is set to 'USB' position.
- **USB – UART.** The development kit is fitted with a (U9) FTDI FT232R USB to UART converter which provides USB-to-Virtual COM port on any Windows PC (XP or later). Upon connection, Windows auto-installs the required drivers. For more details and driver downloads, visit http://www.ftdichip.com/Products/FT232R.htm.
- **UART interface driven by USB FTDI chip.** In normal operation, the BT900 UART interface is driven by the FTDI FT232R USB to UART converter in the development board. This is used for the BT900 series module *smart* BASIC runtime engine FW upgrade or to load *smart*BASIC application script.

4.3.3 UART Interface Driven by External Source

- UART interface driven by external UART source. The BT900 module UART interface (TX, RX, CTS, RTS) is presented at a 2.54 mm (0.1") pitch header (J10). To allow the BT900 UART interface to be driven from the breakout header connector (J10):
  - The development board must be powered from a DC jack (CN1) or AAA batteries (J7) and switch SW4 must be in DC position.
  - The FTDI device must be held in reset which is achieved automatically by removal of USB cable or SW4 is in the DC position.
  - Micro-DIP switch CON13 allows the four BT900 UART pins to be physically isolated as well from USB-UART FTDI device. Physical micro-DIP switch body has text "ON" on the closed side. By default, CON13 is closed.

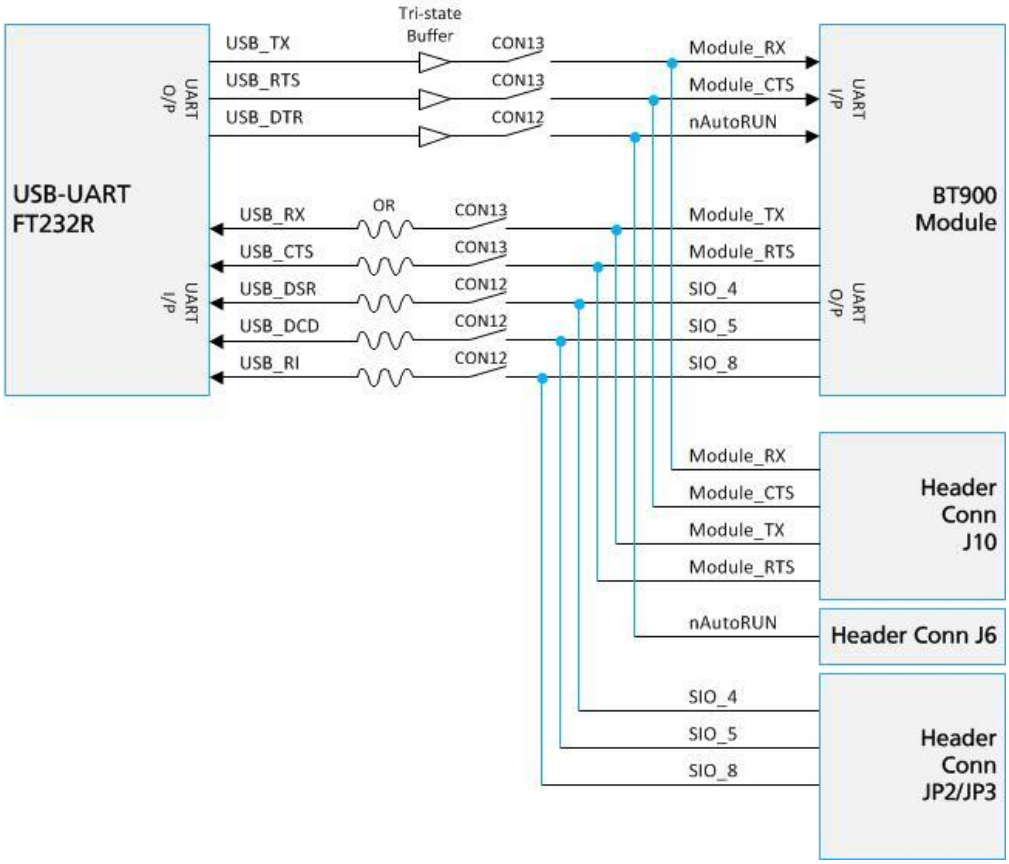


Figure 4: USB to UART Interface and Header to UART interface

- J10 pin-out is designed to be used with an external FTDI USB to UART TTL (3.3V) convertor cables:
  http://www.ftdichip.com/Products/Cables/USBTTLSerial.htm
  E.g. FTDI manufacturer part number for cable: TTL-232R-3V3

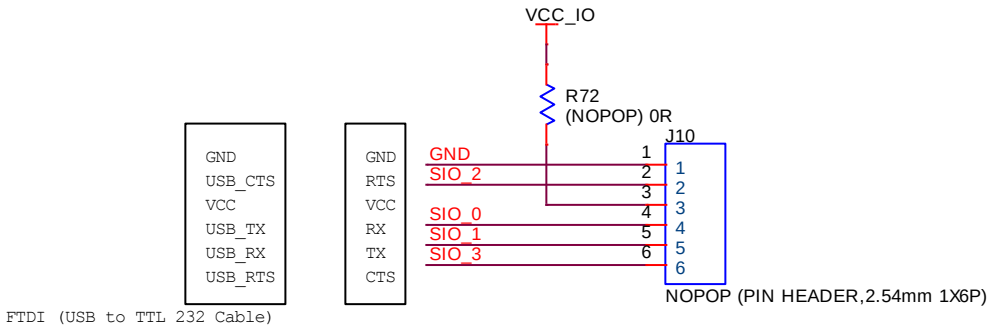


Figure 5: J10 wiring to match FTDI USB to UART cable (TTL-232R-3V3 cable)

4.4 nAutoRUN Pin and Operating Modes

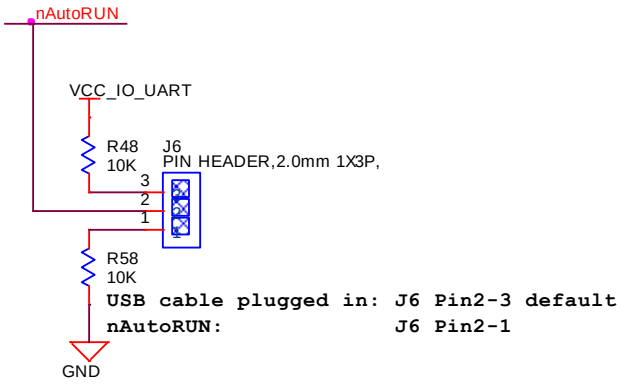
On the development board USB_DTR output (FTDI chip U9) from PC is wired to BT900 module pin 3 (nAutoRUN).

Note: *smart*BASIC runtime engine FW checks for the status of nAutoRUN during power-up or reset. The nAutoRUN pin detects if the BT900 module should power up into Interactive/Development Mode (3.3 V) or Self-contained Run Mode (0V). The module enters Self-contained Run Mode if the nAutoRUN pin is at 0V and an $autorun$ application exists in the modules file system, then the *smart*BASIC runtime engine FW executes the *smart*BASIC application script automatically; hence the name *Self-contained Run mode*.

The nAutoRUN pin inhibits the automatic launch $autorun$ application on power-up. Tying nAutoRUN to 3.3V inhibits the $autorun$ application from running. The J6 3-pin header allows a jumper to be fitted to select between the two operating modes.

Note: Micro DIP switch CON12 pin2-6 **must** be open when using J6 3-pin header to select nAutoRUN function.

Table 2: BT900 nAutoRUN pin

nAutoRUN pin	BT900 Operating Mode		
	Interactive/ Development Mode	Self-contained Run Mode	Circuit
J6 jumper position			

Micro DIP switch CON12 allows the 4 x UART signals from the FTDI chip (USB_DSR, USB_DTR, USB_DCD, USB_RI) to be disconnected from reaching the BT900. By default the DIP switch is open.

Since BT900 nAutoRUN pin 3 is connected to PC FTDI USB_DTR line, the Micro DIP switch:

- CON12 (pin 2-6) **must** be CLOSED (in ON position) to allow the PC (using uWTerminal) to control nAutoRUN (pin 3 on BT900); with no jumper fitted to J6 (see Figure 6).
- CON12 (pin 2-6) **must** be OPEN to allow nAutoRUN (pin3 on BT900) to be controlled by J6 (with jumper fitted to J6 pin 1-2) to select nAutoRUN (Figure 7).

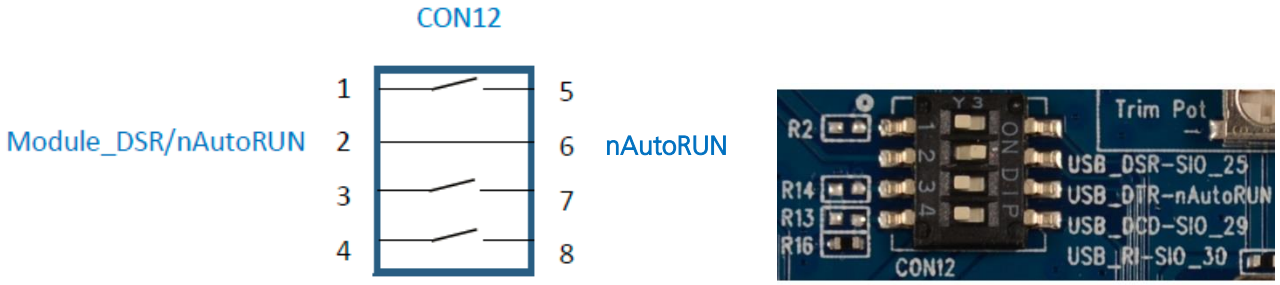


Figure 6: Micro DIP switch CON12 closed (nAutoRUN controlled by PC)

Note: The additional lines of the DIP switch CON12 are not currently utilised and need to remain open, as shown in Figure 6.

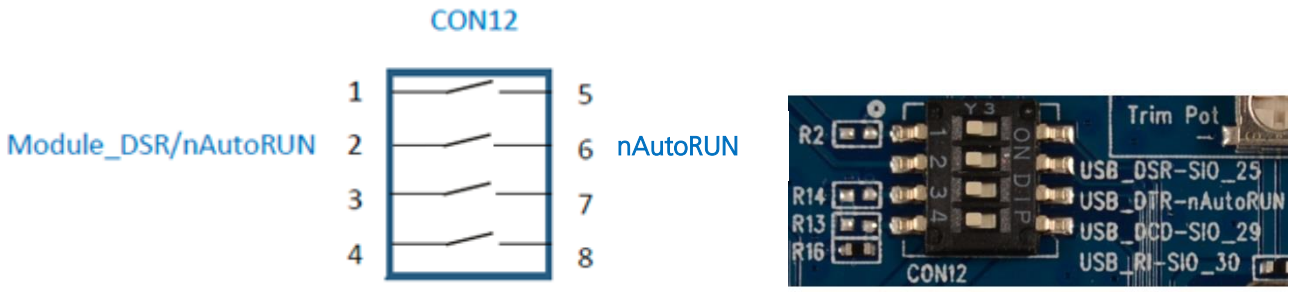


Figure 7: Micro DIP switch CON12 open (nAutoRUN controlled by J6 jumper on pin 1-2)

4.5 OTA (Over the Air) *smart*BASIC application download

It is possible to download *smart*BASIC applications over the air to the BT900. To enable this feature, SIO_19 must be pulled low to GND externally (on power up).

On the development board, header connector JP4-pin 8 brings out the BT900 SIO_19; JP4-pin 9 brings out GND. To pull BT900 SIO_19 low (to GND), connect JP4-pin 8 (SIO_19) to JP4-pin 9 (GND) by fitting a fly-lead between these pins.

Refer to latest FW release (v1.9.2.0) documentation and *smart*BASIC user manual for details. Additionally, Laird has authored an Application Note explaining how to download applications over the air. All of these materials are available in the documentation tab of the BT900 product page at www.lairdtech.com/products/BT900-Series.

4.6 VSP (Virtual Serial Port) connection to Host device

VSP allows the remote wireless device to bridge to the host device UART that is connected to the BT900 UART. SIO_19 pin must be pulled low externally to GND (on power up) to enable the VSP (Virtual Serial Port over BLE) for connection to the host device.

Refer to latest FW release (v1.9.2.0) documentation and *smart*BASIC user manual) for details.

5 SOFTWARE

The development board connects the BT900 module to a virtual COM port of a PC or other device. From a PC, you can communicate with the module using Laird's UW Terminal application (version 6.51 or newer).

UW Terminal is a terminal emulation application capable of running on Windows 98, ME, 2000, XP, Windows 7, and Windows 8 operating systems. It was developed specifically to aid development and testing of Laird modules. It allows connection to serial devices using any combination of the communications parameters listed in Table 5-1.

Table 5-1: Communication Parameters

COM Port:	1 to 255
Baud rate:	1200 to 921,600 **Note:** Baud rate default is 115200.
Parity:	None, Odd, Even
Data Bits:	8
Stop Bits:	1 or 2
Handshaking:	None or CTS/RTS

Note: Baud rates higher than 115200 depend on the COM port capabilities of the host PC and may require an external USB – RS232 adapter or PCMCIA card.

The benefits of using UW Terminal include:

- Continually displayed status of DSR, CTS, DCD, and RI
- Direct control of DTR on the host PC via a check box
- Direct control of RTS, if CTS / RTS Handshaking is disabled when UWTerminal is launched
- Sending of BREAK signals
- BASIC tab provides standalone testing and development of *smart*BASIC ** applications and allows UWTerminal operation to be automated.
- The BASIC embedded into UWTerminal, since version 6.20, shares the same core functionality as the BT900 series module.
- Additional built-in features (right click in Terminal tab screen) to accelerate development including Automation and various XCompile / Load / Run options for downloading *smart*BASIC applications into the BT900.

Note: Full details on *smart*BASIC are available in the *smart*BASIC User Manual available for download at the Laird website. This document also includes a basic introduction to the UW terminal program.

Tip: If the module returns a four hex digit error code: In UwTerminal, select those four digits, right-click, and select **Lookup Selected ErrorCode**. A description of the error is printed on screen.

6 BREAKOUT CONNECTOR PINOUTS

6.1 JP2, JP3, JP4, JP5 SIO (Special Input / Output Sockets) Breakout Connectors

Access to all 28 BT900 series module signal pins (SIO's = signal Input /Output) is available on four connectors JP2, JP3, JP4, JP5 (2.54 mm pitch 2x5 headers).

Note: The BT900 module signal pins designation SIO (Signal Input /Output).

- The default type is DIO (Digital Input or Output) or UART (on fixed pins)
- The alternate type is either AIN (Analog Input ADC), I2C, SPI, DIO (on fixed pins), PWM or FREQ and WKUP or Ext Interrupt
- Alternate function is selectable in *smart*BASIC application
- DIO or AIN functionality is selected using the GpioSetFunc() function in *smart*BASIC
- AIN configuration selected using GpioSetFunc() function
- I2C, UART, SPI controlled by xxxOPEN() functions in *smart*BASIC
- SIO_0 to SIO_3 are DIO by default when $autorun$ app runs on power up

These breakout connectors can interface to a wide array of sensors with the BT900 function user configurable by *smart*BASIC application script from the default function (DIO, UART) to alternate functions (AIN (ADC), I2C, SPI, DIO, PWM or FREQ and WKUP or Ext Interrupt). The BT900 development kit incorporates additional connectors and cables inside the box, to enable simple, hassle-free testing of the multiple interfaces.

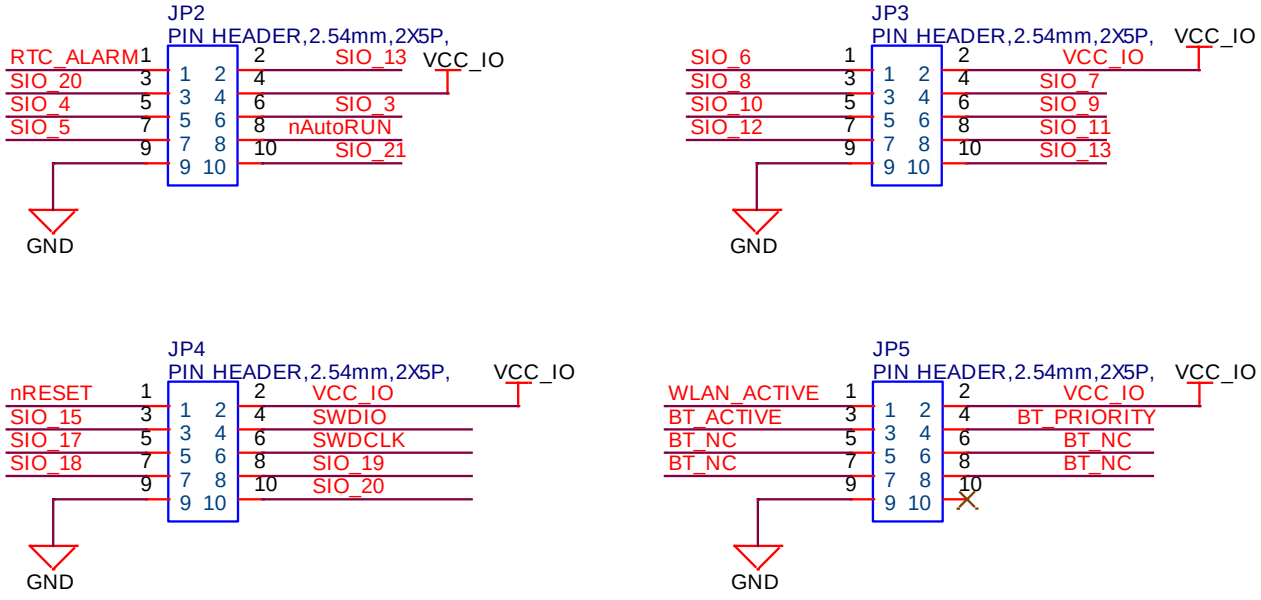


Figure 8: Breakout board connectors

6.1.1 JP2

In the *smart*BASIC application code written to use sensors on the development board (including the Temperature sensor (U1), Trim Pot(VR9), Buzzer (BZ1), LED1, LED2, Button1 (SW1, and Button2 (SW3), I2C device (U13), SPI device (U12), the SIO pins direction and type (that these sensors are connected to, SIO_21, SIO_20, SIO_12, SIO_17, SIO_18, SIO_13, SIO_20, SIO_10, SIO_12, SIO_6 to SIO_9 respectively) must be set in the *smart*BASIC application to override the defaults in the BT900 firmware.

JP2 Pin	Pin Designation	Default Function[1]	Alternate Function	Default Direction[2]	Comment
1	RTC_ALARM				Signal output from I2C device
2	SIO_13	DIO	PWM or FREQ	Input	Input for BUTTON1 (SW1) on DVK via CON7 (fit 2-pin jumper on CON7).
3	SIO_20	DIO	AIN or WKUP1 or Ext Interrupt	Input	Input for BUTTON2 (SW3) on DVK via CON8 (fit 2-pin jumper on CON8). Connects to Analogue device (Trim Pot) on DVK, via CON14.
4	VCC_IO			Output only	Do not inject DC voltage into this pin.
5	SIO_4	DIO		Input	UART_DTR (via CON12) on DVK
6	UART_CTS	UART	SIO_3 or WKUP4 or Ext Interrupt	Input	
7	SIO_5	DIO	Ext Interrupt	Input	UART_DCD (via CON12) on DVK
8	nAutoRUN	DIO		Input only	UART_DSR (via CON12) on DVK
9	GND				
10	SIO_21	DIO	AIN	Input	Connects to Analogue device (Temp Sensor) on DVK, via CON14.

[1] *DIO: Digital Input or Output*
[2] *Default Direction In BT900 module smart*BASIC runtime engine FW

6.1.2 JP3

JP3 pin	Pin Designation	Default Function[1]	Alternate Function	Default Direction[2]	Comment
1	SIO_6	DIO	SPI_MISO	Input	Connects to SPI device (RTC chip) on DVK, via CON16.
2	VCC_IO			Output only	Do not inject DC voltage into this pin.
3	SIO_8	DIO		Input	UART_RI (via CON12) on DVK. SPI_CS output connects to SPI device (Eeprom chip) on DVK, via CON16.
4	SIO_7	DIO	SPI_MOSI	Input	SPI_MOSI is an output in SPI master mode. Connects to SPI device (Eeprom chip) on DVK, via CON16.
5	SIO_10	DIO	I2C_SDA	Input	Connects to I2C device on DVK, via CON15.
6	SIO_9	DIO	SPI_CLK	Input	SPI_CLK is an output in SPI master mode. Connects to SPI device (Eeprom chip) on DVK, via CON16.
7	SIO_12	DIO	PWM or FREQ	Input	Connects to BUZZER output on DVK, via CON15.
8	SIO_11	DIO	I2C_SCL	Input	Connects to I2C device (RTC chip) on DVK, via CON15.
9	GND				
10	SIO_13	DIO	PWM or FREQ	Input	Input for BUTTON1 (SW1) on DVK via CON7 (fit 2-pin jumper on CON7).

[1] *DIO: Digital Input or Output*
[2] *Default Direction In BT900 module smart*BASIC runtime engine FW

6.1.3 JP4

JP4 Pin	Pin Designation	Default Function[1]	Alternate Function	Default Direction[2]	Comment
1	nRESET			Input	Input for button SW2 on DVK. Push to reset BT900.
2	VCC_IO			Output only	Do not inject DC voltage into this pin.
3	SIO_15	DIO		Input	
4	SIO_14	DIO	*****	Input	
5	SIO_17	DIO	PWM or FREQ	Input	Connects to LED1 on DVK via CON14
6	SIO_16	DIO	*****	Input	
7	SIO_18			Input	Connects to LED2 on DVK via CON14
8	SIO_19	DIO	VSP	Input	Pull to GND to enter VSP mode. Use jumper lead to connect to GND.
9	GND				
10	SIO_20	DIO	AIN or WKUP1 or Ext Interrupt	Input	Input for BUTTON2 (SW3) on DVK via CON8 (fit 2-pin jumper on CON8). Connects to Analogue device (Trim Pot) on DVK, via CON14.

[1] *DIO: Digital Input or Output*
[2] *Default Direction In BT900 module smart*BASIC runtime engine FW

6.1.4 JP5 BT-Wi-Fi Coexistence

JP5 Pin	Pin Designation	Default Function[1]	Alternate Function	Default Direction[2]	Comment
1	WLAN_ACTIVE	DIO		Input	Also called WLAN_DENY
2	VCC_IO			Output only	
3	BT_ACTIVE	DIO		Output	
4	BT_PRIORITY	DIO		Output	Also called BT_STATUS
5	BT_NC	NC			DO NOT CONNECT
6	BT_NC	NC			DO NOT CONNECT
7	BT_NC	NC			DO NOT CONNECT
8	BT_NC	NC			DO NOT CONNECT
9	GND				
10	NC	NC			

[1] *DIO: Digital Input or Output*
[2] *Default Direction In BT900 module smart*BASIC runtime engine FW

6.2 Additional Peripherals / Sensors

The BT900 development board provides for simple and hassle free connectivity to a wide range of sensors, but also includes several on-board sensors and options to enable a developer to test functionality straight out of the box.

The additional peripherals and sensors on the development board can be isolated by micro-DIP switches CON14, CON15 and CON16.

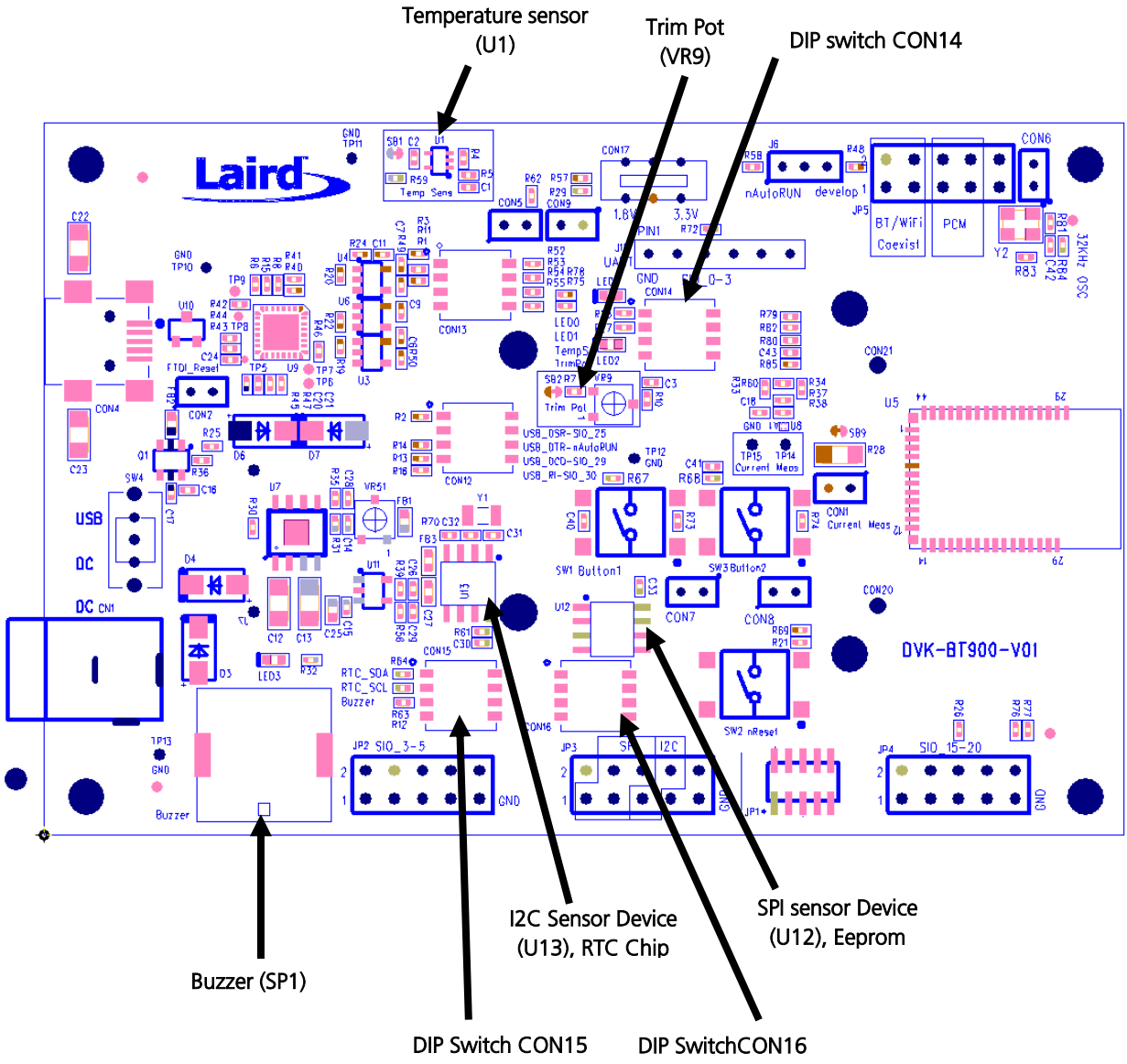


Figure 9: BT900 Development Board

6.2.1 Buzzer

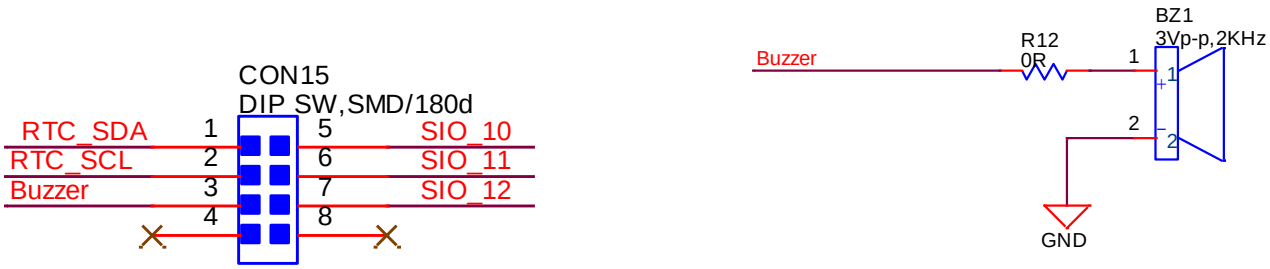


Figure 10: Buzzer

The buzzer (BZ1) ACTC SMD PIEZO BUZZER part number APD-1203-PQ1 can be disconnected from BT900 module by micro-DIP switch CON15. Physical micro-DIP switch body has text "ON" on the closed side.

To drive the buzzer, configure SIO_12 as a digital output using *smart*BASIC GpioSetFunc(12,2,0) and then, for example, write a 0 followed by a 1 to SIO_12 repeatedly in a loop.

Sample *smart*BASIC applications are available from a Laird FAE, or refer to **bzt.buzzer.test.sb** in the *smart*BASIC sample application library on BT900 product pages at: https://github.com/LairdCP/BT900-Applications

6.2.2 Temperature Sensor

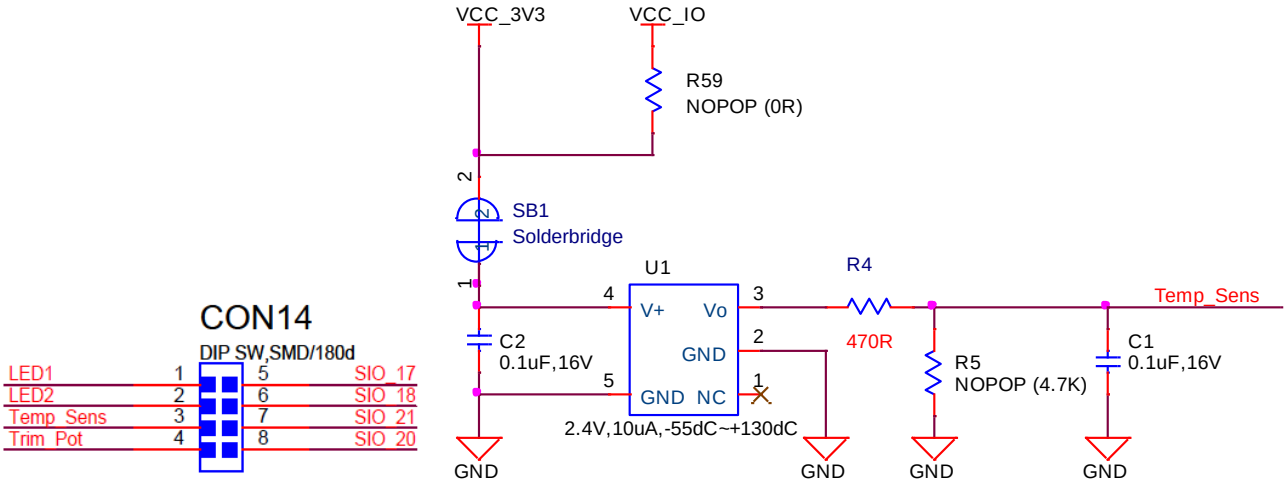


Figure 11: Temperature sensor

The temperature sensor (U1) can be disconnected from BT900 module by micro-DIP switch CON14. Physical micro-DIP switch body has text "ON" on the closed side.

The temperature sensor (U1) can be disconnected from supply rail by cutting the solder bridge SB1.

The development board on-board temperature sensor (TI LM20BIM7 www.ti.com/lit/ds/symlink/lm20.pdf) has an Analogue output that is connected to BT900 module pin SIO_21; but since the LM20BIM7 has an analogue output, the BT900 module SIO_21 digital pin (DIO) must be configured as AIN analogue input (ADC). To configure the SIO_21 pin from DIO pin to Alternate function AIN, see file "ts.temperature.sensor.sb" in the *smart*BASIC sample application library on BT900 product pages at: https://github.com/LairdCP/BT900-Applications

Key specifications of the LM20BIM7:

Output type	Analogue output
Accuracy at 30°C	±1.5°C ±4°C (max)
Accuracy at 40°C to +85°C	approx. ±2.5°C ±5°C (max)
Power supply voltage range	+2.4 V to 5.5 V
Current Drain	10 uA (max)
Output impedance	160 Ohms (max)

LM20BIM7 datasheet states Temperature (T) to Voltage output (Vo) relationship approximated as a linear equation (for temperature range of -40°C to +85°C):

Vo(mV) = -11.79mV/°C x T + 1858.3

Table 2 gives calculated Vo versus temperature:

Table 2: Vo vs. Temperature

Temperature (T)	Typical Vo
+80°C	+924.7mV
+70°C	+1041.4mV
+60°C	+1158.1mV
+50°C	+1274.8mV
+40°C	+1391.5mV
+30°C	+1508.2mV
+20°C	+1624.9mV
+10°C	+1741.6mV
+0°C	+1858.2mV
-10°C	+1975.0mV
-20°C	+2091.7mV
-30°C	+2208.4mV

6.2.3 Trim Potentiometer

The Trim Potentiometer is located in the middle of the development board to the right hand side of the coin cell holder. It is labelled 'Trim Pot' on the silkscreen.

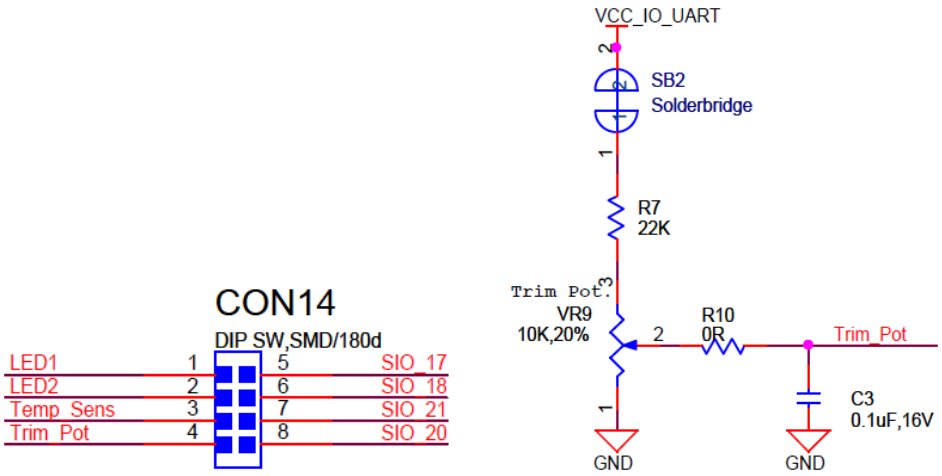


Figure 12: Trim Potentiometer

The Trim Potentiometer (VR9) can be disconnected from BT900 series module by micro-DIP switch CON14. Physical micro-DIP switch body has text "ON" on the closed side.

The Trim Potentiometer (VR9) can be disconnected from supply rail by cutting the solder bridge SB2.

The Trim Potentiometer generates a voltage range of 0 V to ~0.9 V at C3 (CON14 pin4), see file *tpt.trimpot.test.sb* in the *smart*BASIC sample application library on BT900 product pages at:
https://github.com/LairdCP/BT900-Applications

6.2.4 Push Buttons and LEDs

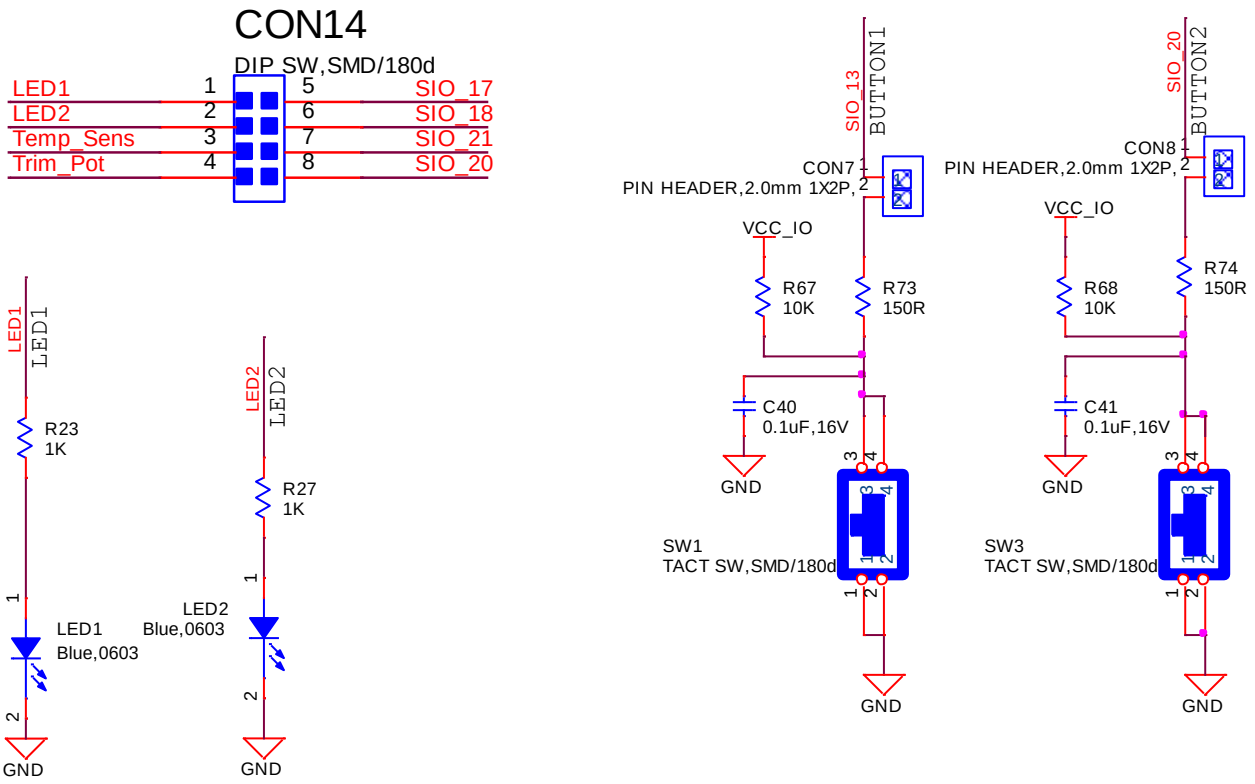


Figure 13: Push buttons and LEDs

The two push buttons and two LEDs on the DVK-BT900-V01 are connected to dedicated SIOs of the BT900 module.

Part	SIO
Button 1 (SW1)	SIO_13
Button 2 (SW3)	SIO_20
LED 1 (LED1)	SIO_17
LED 2 (LED2)	SIO_18

If SIO_18 and SIO_19 are needed elsewhere, the LEDs can be disconnected by micro-DIP switch CON15. Physical micro-DIP switch body has text "ON" on the closed side.

The buttons have external pull-up resistor, so to use the buttons the SIO_13 and SIO_20 pins must be configured as an input (with internal pull-up resistor enabled or disabled). Refer to the *smart*BASIC application example "btn.button.led.test.sb" in the *smart*BASIC sample application library on BT900 product pages at: https://github.com/LairdCP/BT900-Applications

The LEDs are active high, meaning that writing a logical one ("1") to the output pin illuminates the LED.

One example of when push buttons can be used is when a *smart*BASIC application is written to simulate a generic data profile. Push buttons can then be pressed to increment or decrement, such as a heart rate.

6.2.5 I2C device

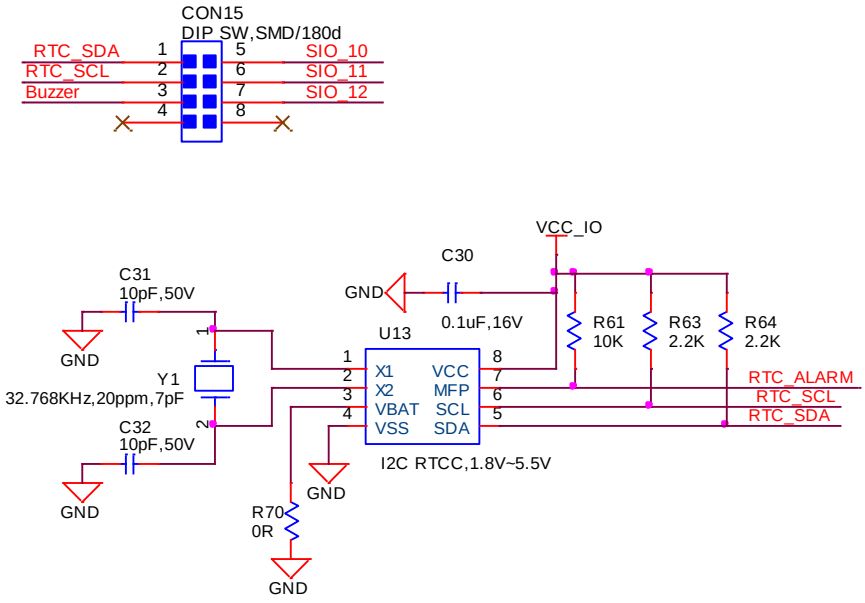


Figure 14: I2C device

The I2C device (U13) on the DVK-BT900-V01 can be connected to dedicated SIOs of the BT900 module via micro-DIP switch CON15. Default the SPI device is disconnected (micro-DIP switch is open) from BT900. Physical micro-DIP switch body has text ON on the closed side.

Refer to the following *smart*BASIC applications that make use of the I2C RTC chip to prove the BT900 I2C interface:

- **rtcc.client.sb** (Update RTC Client application)
- **rtcs.erver.sb** (Update RTC server)

6.2.6 SPI device

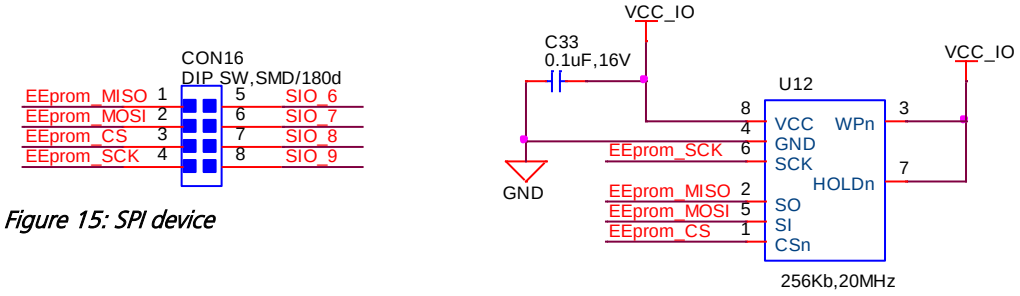


Figure 15: SPI device

The SPI device (U12) on the DVK-BT900-V01 can be connected to dedicated SIO's of the BT900 module via micro-DIP switch CON15. Default the SPI device is disconnected (micro-DIP switch is open) from BT900. Physical micro-DIP switch body has text "ON" on the closed side.

Refer to the following *smart*BASIC applications that make use of the SPI device (an EEprom chip) to prove the BT900 SPI interface:

- spic.client.sb (Update CMD application and Add SPI sample)
- spis.erver.sb (Fix SPIserver)

7 OTHER FEATURES

7.1 Current Consumption Measurement

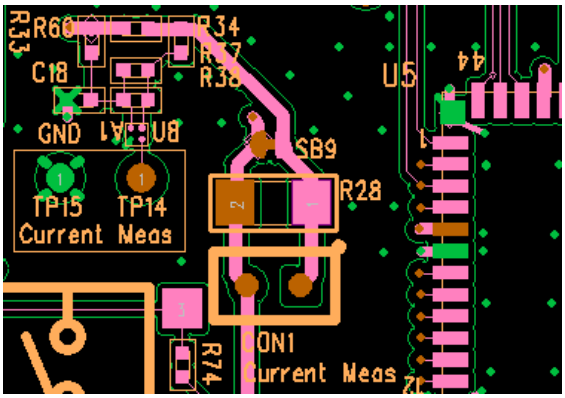
A removable jumper (fitted on to header CON1) is provided to break the power supply line directly to the module (if SB9 is cut), allowing you to measure current consumption. For normal operation, you must fit a jumper on header connector CON1.

IMPORTANT: To achieve various low power modes using the BT900 series module on the development board, see the following sample *smart*BASIC applications available from the GitHub repository:

- uc.uart.close.standby.doze.sb
- uclp.uart.low.power.operation.sb
- lp.low.power.deep.sleep.sb

Note: This only measures the current consumption of the BT900 series module **only**.

The current drawn by the BT900 series module can be monitored on the development board. Figure 16 shows the schematic (and location of measuring points on PCB) related to current measurements.



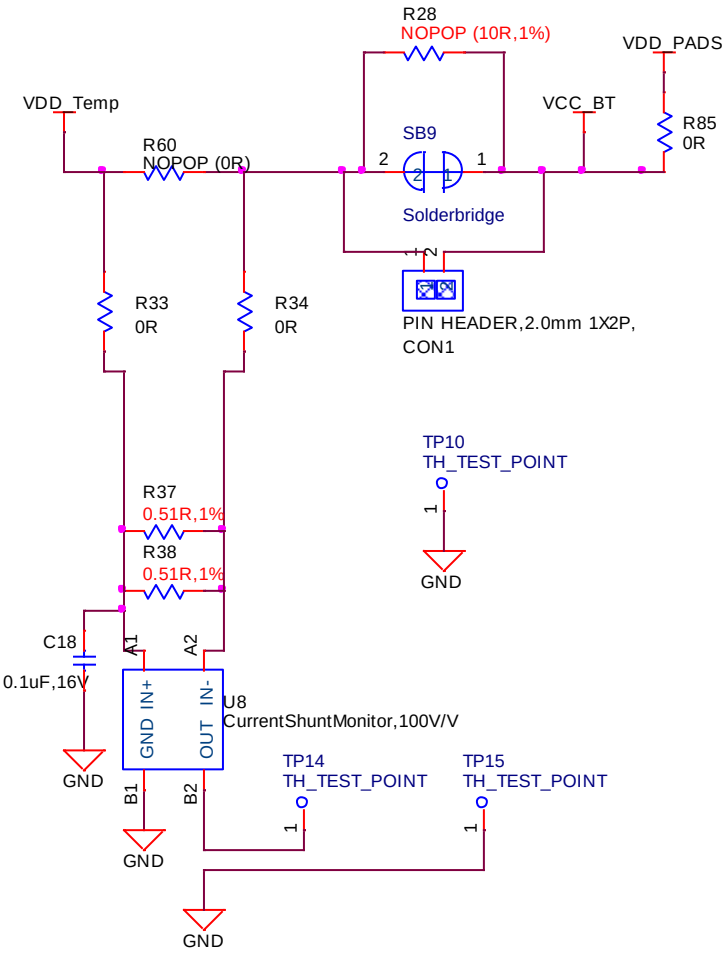


Figure 16: Current measurement Schematic and component location

To prepare the board for current measurement, **cut the shorting of the solder bridge SB9.** After this modification there are two primary ways to measure the current consumption:

- **Using Ammeter –** Connect an ampere meter between the two pins of connector CON1. This monitors the current directly.
- **Using Oscilloscope (Note1) –** Mount a resistor on the footprint R28. The resistor should not be larger than 10 Ohm. Connect an oscilloscope or similar with two probes on the pin on the CON1 connector and measure the voltage drop. The voltage drop is proportional with current consumption. If a 1 Ohm resistor is chosen, 1 mV equals 1 mA.

There is also a third way to measure current:

- **Using Current Shunt Monitor –** The current drawn by the BT900 module can be monitored using the Current Shunt Monitor (CSM), INA216A3YFFR, TI (U8). The gain of INA216 is 100 V/V for lowest possible drop voltage.

Note: The Using Current Shunt Monitor method allows the dynamic current consumption waveforms on oscilloscope as the BT900 radio operates. This can provide insight into power optimization. The accuracy of the CSM circuit drops when measuring currents down towards 200uA value.

Current consumed by the BT900 module is measured as a voltage (proportional to the current) using the CSM by connecting measuring voltmeter OR oscilloscope to TP14 Connect measuring voltmeter or oscilloscope GND to TP15.

$$I(mA) = Vmeas_TP14(mV) / 25.5$$

CAUTION: Take care not to short TP14 (the Current Shunt Monitor IC (U8)) output to GND, as that will permanently damage the IC U8.

Note on CON1: CON1 is used for current measurement only.

8 Additional Documentation

Laird offers a variety of documentation and ancillary information to support our customers through the initial evaluation process and ultimately into mass production. Additional documentation are available from the Laird BT900 product pages: www.lairdtech.com/products/bt900-series

For additional questions or queries as well as to receive local technical support for the BT900 development kit refer to the Embedded Wireless Support Center: http://ews-support.lairdtech.com

CONN-GUIDE_DVK_BT900
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